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ABSTRACT

This report describes student participation in computer applications through classroom use and through student-consultants. Three types of outcomes of computer use are explained in terms of "student activity." The first activity, "computer literacy," concerns the impact of computers in society, how computers affect each citizen, what must be known to operate computers, and how to prevent computer abuse. "Computer language acquisition," the second activity, refers to the use of BASIC and the computer facility itself by students and teachers. The last activity, "a feeling of community," is the sharing of computer resources by all students and by all teachers. In conclusion, the various roles of maxicalculators (e.g., HP 9830 and Wang 2200) versus time-sharing, interactive terminals in computers are discussed. (DAG)

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The Illinois Series on Educational Applications of Computers

STUDENTS: WHERE THE ACTION IS!

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ABSTRACT

Applying computers for the whole school requires active student participation: all of the students use the computer for projects or classwork, and a small cadre of student-consultants contributes directly to efficient use of the computer in the school. These student activities generate computer literacy, the acquisition of a computer language (BASIC), and a feeling of community throughout the school. The applications and programming of the computer will grow out of the activities or needs of the student groups involved.

1. Introduction

Schools are responsible for providing educational resources for their students. Resources include human ones--teachers, aides, administrators and students; and inanimate ones--laboratories, computers, and other equipment, in addition to the school plant.

Computers are one of the newer resources. When computers are used for the whole school (Reference 1), students play a central role because all of the students use the computer at some time, and a certain fraction of the students (a cadre that we shall call "student-consultants"*) support, through their computer work, a large part of the computer uses for everyone in the school. This fraction of the students become responsible for providing much of this new, computer-based educational resource for the school.

Students, by being served by the computer and by providing support, are truly "where the action is." In both roles, the students express and help develop the educational philosophy of the school. The purpose of this paper is to describe these activities of students in the "computers for the whole school" philosophy.

The students' activities are evident in three types of outcomes of computer use for the whole school: computer literacy, knowledge of the BASIC language, and "community."

We shall first examine these outcomes in some detail and also the nature of elementary instruction in BASIC and in computer use; then discuss why it is that students can and should be a resource in computers for the whole school; and finally, the implications of these student activities in choosing hardware and developing software.

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* These individuals are both students and consultants. We therefore use the hyphenated form "student-consultant."

Since we shall find it convenient to use the term maxicalculator, we need to say more about it here. We use this term to describe electronic calculators that are as powerful as the older minicomputers but more flexible and portable. The Hewlett-Packard 9830 and the Wang 2200 are examples of such maxicalculators that are especially well suited to provide computers for the whole school.

A maxicalculator system includes a multiple-use keyboard, a maxicalculator with "wired-in" BASIC, a fast thermal printer, a fast batch reader for mark sense and punched cards, and a tape cassette drive for secondary memory. We note that a maxicalculator, which serves the whole school community, costs from $5,000 to $15,000.

2. Computer Literacy

What can a computer do and what can't it do for a student? What is it like to run a computer or interact with it? What responsibility do students or others have to see that computers are used wisely and equitable in the school? The student (and the teachers and administrators) have taken a step toward computer literacy when they can answer such questions as these.

Computer literacy covers the impact of computers in society, how they affect each student and his fellow citizens, what must be known about computers in order to enjoy the services they provide, and the need to prevent possible abuses of computer power.

Computer literacy is gained through specific discussions in classes* with well-informed teachers and visitors, by assigned readings, and --what we stress here--through students' own experience with a computer and observation of others using computers. Students should be advised: "EXPERIMENT! That's one of the many things the computer is here for."

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* Schools that place great emphasis upon computer literacy may give this as a separate course treating, for example, the computer's capabilities and limitations, the historical development of computers, the various social implications of the computer and its various uses in industry, business, education and government (Reference 2). Others may feel that a separate course would add to the "mystique" of computing and prevent the computer from becoming a real tool--like a hammer.

Let us look at a few types of student experiences that are related to computer literacy. These experiences will often be tailored to the needs of each student. He will use realistic simulations of problem solving and decision making that will be encountered in jobs or in later schooling (for example, running a business, doing accounting, or controlling environmental pollution); and the experiences can include mind-stretching and aesthetic activities, ones that stress synthesis or realizations of imaginative processes. The maxicalculator can help to bring understanding and community across these varied, problem oriented and value oriented pursuits.

Students find, in computer related experience, that the logic of a computer suits one kind of intelligence and not another, or fits one situation or problem, in the classroom or in society, better than another situation or problem. Thus there is visible evidence available to them of what computers can and cannot do. Properly handled, computer experience will give students both confidence (and some humility) regarding their ability to use computers. They must also be able to perceive and choose among, and respond to, different cognitive styles and needs, whether seen in a text, in the classroom, or on the computer.*

By experimenting with the computer in areas like social studies and humanities, students can discover that logical analysis "even with a computer" does not by itself answer questions about values, whereas such analysis does give immediate results in mathematics or physics because of the quantifiable nature of the questions asked. So much the better. Neither scientists nor students should exaggerate the power of the tools they use, whether computers or other technology. Students can learn also, in other computer-based experiences, that the computer should leave

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* For example, a student-consultant may possess a "stimulus-centered" cognitive style and be required to help a student with an "egocentric" cognitive style. The consultant is then focusing on the aspects of the computer itself whereas the other student is viewing the computer in a personalized, affective manner. Thus, the consultant would be faced with helping the student overcome a concern with the "personality" of the computer--something which doesn't exist for the consultant.

them, (or scientists or teachers,) more free to do that which is truly important--to perform those tasks that involve taste, judgment, and subtle analysis.

Literacy includes appreciation of the interdisciplinary character of computer applications. Computer use helps bring the students in different subjects and tracks together in cooperative efforts because it is often used in similar ways in different subjects. Indeed, new areas of computer use may be developed by the students and taechers working together on the computer. Such cooperative uses of the computer contribute to the feeling of community across the school that will be discussed in a later section.

Finally, computer literacy implies understanding that the computer itself does not discriminate with respect to sex, color, age, or wealth. However, a student can easily see if people discriminate in giving various users within the school community access to the computer.

3. Training in BASIC and the Use of the Computer

There are two types of training to be considered, that in the use of the computer language, BASIC, and that in the use of the computer facility itself, the "hardware." Each type of training can be broken down into simple, logically related steps. Only the early or basic part of each type of training will be discussed here, the part that is needed by all students, and by those teachers who need the same level of computer expertise achieved by the "average" student. The students can receive the basic training appropriately during their eighth-grade mathematics or science courses. The teachers will gain their understanding of BASIC and the computer through private study, informal workshops and working sessions, and through working with the expert student-consultants.

The content of each type of training is determined in part, but only in part, by the nature of the computer input facility, that is, whether the input is by mark sense cards or through terminals to a time-sharing system. The language BASIC is nearly the same on most computers that support it, and this is most

nearly the case for those parts of the language used in this training in elementary BASIC. The outcome should be the same, regardless of the computer facility, that is, the student acquires the ability to ask the computer to solve problems that are suitable for computer solution. Our discussion will assume input by mark sense cards.

While learning the use of the BASIC language, the student (or teacher) should also learn how to put a program written in BASIC into the computer. BASIC, itself almost computer-independent, is thus taught in the context of the specific computer and input devices that are available to the students and the teachers at their school. In this way, tangible, visible interaction with the computer ("It's actually doing what I told it to do!") motivates the initial learning of BASIC.

There are many published guides to teaching elementary BASIC (see References 3 and 4, for example). Often, however, teachers wish to write their own notes for teaching BASIC, designed for the particular needs of the students and classes in their school. Below is an outline of one such set of notes (Reference 5). Notice that the notes do provide training in computer use (that is in computer input) that is developed in parallel with the early training in BASIC.

Outline of Elementary BASIC and Computer Operations*

a. Introduction: the role of computer languages and of our computer language, BASIC; LET, the first computer instruction to learn; statements and cards

b. INPUT: giving instructions and commands to the computer; mark sense cards (simulated, until stage (i) of the training by paper exercises); codes familiar in every day life and codes in the computer; definition of a computer program

* This training can be made partly self-instructional with self-administered quizzes for the student to check competence at each stage of the training.

c. Output: What the computer produces for the user; two more instructions, PRINT and END; sketching the computer's memory.

d. *Fundamental operations and codes inside a computer; switches, binary representation of numbers, letters, and of arithmetic and logical operations; the "brainlessness" of the computer; why engineers designed these representations or codes (so the user can tell the computer what to do, and the computer can do it)

e. More instructions: PRINT "JOE"; the SQR function; line numbers

f. Solving classes of problems on computers: use of the instructions READ and DATA

g. Branching: the instruction GO TO; more format control (column headings and spacing)

h. Commands (to tell the computer how to handle your program when not executing it): SCRATCH, LIST, RUN, CARDl

i.**Exercise for making the mark sense cards

j. Another instruction, IF....THEN

k. Characters and strings: $ variables

l. Arrays: the instructions DIM and COM

m. FORMAT and other advanced instructions.

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* Some teachers may prefer to postpone this discussion until later in the elementary BASIC training.

** This is the first time that the cards are used by the students, but by now the students have a repertoire of instructions and commands they understand and which they have connected with their earlier, noncomputer experience. They will use the cards in writing programs and running them on the computer or maxicalculator.

4. Community

Implementation of computers for the whole school increases the feeling of community across the school. This enhanced feeling of community* comes from the experiences of the students (and others in the school) in sharing the use of the computer resources. The computer is not a resource just for one department nor just for an elite group of students. The experiences gained by being in contact with the computer are nicely classified by two kinds of student activity, each of which contributes to community: the activities of all students who share the computer as a resource and the activities of the student-consultants who share responsibility for the effective use of the resource.

4.1 Service to All Students

Let us look at a number of different ways in which computers can be of service to all students.

a. Even though the school's computer may support more than one computer language, it is one language, BASIC, that is used most frequently by everyone that programs for the computer, whether large or small programs, and each user sees that this language is adaptable not only to one's own problems but also to computer uses by others in the school community.

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* A second type of "community," that within the city or district supporting the school, is also important to the success of computers for the whole school. Only if there are good relations between this second community and the school will the students have a good start toward positive but critical appreciation of what computers and other resources in the school can do for them. In this paper we shall confine our discussion to the first type of community, that within the school.

The spirit of this first type of community is contained in this paraphrase of the words of the 17th century mystic, Isaac Penington, "...for this is the true basis of community, not that a person walks and does just as I do but because I feel the same spirit and life in him--this is far more pleasing to me than if he walked just in that track wherein I walk."

b. Students involved in studying aspects of science or technology find many applications of the computer. However, there are many students primarily or wholly involved in subjects other than science or technology, and the computer can serve them also, often in ways that are immediately related to the students' personal interests. Some of the examples are (see also References 6 and 7): in music, the analysis of notation and the writing of primitive canons; in Latin, the codification of grammar or vocabulary; in psychology, the analysis of personality test results; and in domestic science, the yards of cloth required for a garment design. In each of these uses of the computer, students also gain computer literacy, in the form of added understanding of what the computer can or cannot do.

c. The students most gifted in using the computer should have their day too, neither being neglected nor dominating computer usage. (See Section 5).

d. Some students will continue to use the computer for a special reason, after their first introduction to it, because they will be working in the field of data processing after graduation from high school. The computer can serve them, but not to the exclusion of any of the other users. Training in data processing is not the primary goal in the philosophy of computers for the whole school.

e. Many students convince themselves that math is logical; therefore, if they're not good at math, then they're not logical. This attitude should be defeated because a lot of students with an expectation of failure are afraid to try mathematics. They put their best effort forward only to be embarrassed by making mistakes. They should, instead, come to expect to be able to understand math (or basic computer science or

business arithmetic...), rather than to expect not to be able to understand a subject. The computer helps these students because it is both private and patient, in its assistance in drill, as a tutor in a subject, or as a simulator of many different phenomena.

f. The computer liberates students from thinking like the teacher or textbook. It has long been recognized that a certain kind of "intelligence" is required to "succeed" in school--a kind of intelligence not particularly better or more useful than any other. The computer is willing and able to accept any argument (and the intelligence that lies behind it) that falls roughly into the category of Aristotelian logic. (This is the logic of the Western world, which perhaps should warn us again of the limitations of computers.)

g. Computers lose part of their mystique, as they should, when they become the students' servants. Computers also lose another part of their mystique when the student is allowed unrestricted experimentation. The computer accepts almost any combination of nonsense and inspiration input by the student, anything produced by intuition or design or guesswork or error, and treats this input in an entirely consistent manner, giving results that are more or less complete, with some indication to the student as to why these results occur.

4.2 Computer Services Provided by Students

A certain number of the students, probably a few percent of them, will learn how to use the computer extensively and with great skill. In computers for the whole school, their computer activity will serve both their personal interests and the computer needs of others, teachers, administrators, or fellow students.

Student-consultants can be found among the students with high or low academic achievements, but the computer capabilities of student-consultants can be very great indeed. For example, two high school students in British Columbia won a national contest for professional programmers; and in Connecticut a freshman student is writing lessons for the PLATO CAI system, performs conputer analyses of data from cell membrane studies, and will be co-author of a paper on these studies.

The role of these student-consultants is an essential part of computers for the whole school and its community. They have opportunities to observe that their contributions to the school community, by assisting others in using the computer, provides privileges and recognition for their expertise as well as responsibility for the quality of their work. It is a valuable life experience--one of few available in school.* Let us look at some of the activities of these student-consultants.

a. Given adequate initial definition of a computer job by a client (teacher, student or administrator), student-consultants (working individually or in teams) can do the job of computer operation or programming and also show what allocation of resources (computer capabilities, computer time, programming skills, and time) is necessary to do it. If the job can be and is done they can also determine whether the job is trivial or difficult, a characteristic that often cannot be decided with certainty before the computer job is attempted.

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* Some students have poor academic records but are careful, accurate typists. They can also participate in the school community. Such students can, for example, use the maxicalculator to produce specialized attendance records, rapidly and efficiently and receive recognition for their work.

And the work of students on administrative applications of computers shows them that there is indeed a human hand in administrative activities!

b. Using properly chosen criteria the student-consultants can check out programs of any kind obtained from any source to find if they are debugged and are adequately documented and explained for each type of user that will depend on that program.

c. Student-consultants can develop and perfect programs (compilers, information systems, schedulers, etc.) that will serve many different users of the computer. In this service programming, and in the programming that develops directly from their personal interests in using the computer, these students are the ones most likely to make use of (and become expert in) more than one computer language, if more than one is available. Thus some students will do good programming in FORTRAN or in an assembly language as well as in BASIC.

d. Student-consultants will be the principal resource in supervising computer use and demonstrating the computer and its uses to other students, and to teachers, administrators, and visitors. Giving an effective demonstration, tuned to a given audience, requires considerable sensitivity and understanding. It is an undertaking which should be taken seriously, for its success or failure may strongly influence the opinions that those seeing the demonstration will retain about computers and their uses. In developing and giving effective demonstrations the student-consultants can gain valuable practice in exposition, in communication and in interpersonal relations.

e. Student-consultants could undertake another computer-based activity, one that serves the other students, and that would challenge their imagination, honesty, and skills to the utmost. The activity is that of developing, administering, and evaluating computer-based instructional materials, a task that has been completed with full success only seldom by their elders.*

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* In one school a few student-consultants prepared in one semester, some three hours of computer-based instructional materials.

All stand to gain in at least two ways from students' efforts to design and evaluate these materials. First, a few of the students will acquire a love of teaching, an appreciation of the assistance that the computer can give to the teacher, and an acceptance of the real challenge of trying to realize the instructional potential of the computer. Second, the students who try their hand at design and evaluation will be bringing a new perspective (closer than the teacher to that of their fellow students) and less of the inflexibility and habitual processes of thinking that become part of the make-up of almost any professional, whether in education or elsewhere.

One way to start this process is for the student-consultant to write a program aiding his or her own classroom work and then alter it so that it will be suitable for helping several other students of different background and capabilities.

5. Students, the PRIMARY Resource in Having a Computer for the Whole School

In Section 2 we saw that a certain fraction of the students (say 2%) become student-consultants to aid others in the school community. In this section we shall discuss why it is advantageous to these student-consultants to be such a resource in these computer applications and also why it is one way, and perhaps the only way, to develop and maintain an adaptive fully implemented philosophy of computers for the whole school, with all the advantages of this philosophy.

5.1 Why is it advantageous to be a student-consultant?

Let us first list many of the types of service and consulting jobs that student-consultants can do.* Students can aid each of the activities that support the instructional applications of computers. They can program, demonstrate,

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* See the previous section for specific examples of student consultant activity.

supervise, and operate the computer and its peripherals, evaluate computer-based lessons and simulations, and articulate these with classroom and laboratory educational experiences. They can also aid each of the activities that support the administrative applications of computers, whether for the principal's office, for individual teachers or for student clubs. The students also, of course, are encouraged to develop programs arising out of their personal interests and capabilities--a privilege earned by responsible service to their clients. They thus have the opportunity of seeing the full picture of computer use for the whole school community while at the same time developing self-respect that supports their cooperative work with others.

These students gain experience in trying to be critical, responsive and responsible in their work. They learn something of the applicability of a problem solving approach, and they will begin to inject value judgments into their thinking as a needed complement to wholly mathematical arguments. They are thus better prepared for judiciously combining values and logic in situations and studies encountered after high school, where often the successful cooperative use of computers and other resources depends upon a proper mix of the human, social, and technological components.

More radically new activities for these students can be developed. One activity for a group of advanced student-consultants would be to take primary responsibility for formulating the specifications of a new component of the computer system in the school (its hardware or its software), and later installing it. Or possibly a student cadre would take on the job of "spreading the word," throughout the school, among selected teachers as well as students, regarding the applications of computers for the educational work of these potential clients. We have already seen precursors of such high level student activities in several schools.

5.2 Why are student-consultants essential?

When in full operation a computer for the whole school requires the efforts of many people with many types of knowledge and understanding--work that continues from year to year as it adapts to the changes in the school community and its detailed purposes. The whole operation is complex, as would be expected for an educational tool (in this case, the computer) that serves so many so well and in so many different ways. But the complex operation is the sum of small pieces each of which can be taken care of by a single person, and that single person will very often be a student.

It is not necessary to examine or describe all of the computer-based operations here in pointing to the essential role of the students. It is enough to give an example which is developed by asking a series of questions.

What work is needed in order to develop a small computer simulation, say for environmental science or for social studies classes? (See Reference 8 for a discussion of such simulations.) An estimate might look like this:

10 hours	library work and design of the simulation
10 hours	programming the simulation for the computer
15 hours	thorough testing and revision before serious use with classes
35 hours	(The total might be 20 hours if one started with an existing computer simulation that had been used in another school.)

Suppose that a teacher will use two simulations next semester, one new and one old (revised) one. The estimate then is that someone must spend some 55 hours (give or take a factor or two) to prepare these two simulations. Who has the time, energy, interest and expertise to do this?

Suppose, further, that there are ten teachers in the school who are already interested in instructional applications of computers and that they wish to use a total of 20 small simulations or programs requiring similar work to prepare.

Some 550 hours of work will be needed to prepare these.* Who has the time, energy, interest and expertise to do this?

The figures can be changed to fit the school and stage of computer utilization, but the point is clear: a fully implemented computer for the whole school requires hundreds, not tens, of hours of programming, revision, and allied activities in each school year.

In most schools today there are few teachers that have the background, interest and time to use BASIC, the widely available and easy-to-use, powerful, computer language. Time is what teachers lack most. The contribution of those teachers who are (or become) competent in the range of activities surrounding educational applications of computers is most important, but this cadre of teachers should concentrate on what only they can do (promoting and demonstrating instructional applications of computers throughout the school and guiding the student-consultants) and not dissipate their efforts in a vain attempt to program for everybody.

The conclusion is clear: in most secondary schools the student-consultants are the only resource for supporting the quantity and variety of computer services that the computer for the whole school needs.

However logical it is, this conclusion would be vacuous if students were unable to provide this large scale, expert support. But it is known, from experience in schools in British Columbia, for example, that they can.

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* Remember that there are many differences in subject, level, style of computer use and of classroom teaching (and therefore of evaluation and of coordination required) for the 20 programs for the ten teachers. If the 550 hours seems a small amount of work in some schools (which seems unlikely), remember also that there are hundreds of 20 minute slots in the teachers' classes that could be used advantageously by students exercising the computer in their studies, if programs for them or guidance for them in the programs they write are available. And then there will also be five or ten programs that administration needs to have written or changed, some of them small and some of them among the largest used in the school!

6. Hardware and Software Needed for Computers for the Whole School

When computers for the whole school is implemented: all students get some familiarity with computer uses, and the student-consultants serve many people in the school community. Development and maintenance of the cadres of students and teachers who make possible this central role of students in computers for the whole school is a difficult task and clearly an important one. It will be assumed for our present discussion that this task can be accomplished and turn our attention to the hardware and software.

Use of the computer by all students or by some teachers in many different classes does impose different requirements than does the use by student-consultants for their aid to others and their personal programming activities, but all of these requirements can be met by the maxicalculator. What requirements are imposed on the hardware and software of the maxicalculator if students are to play these two central roles? In answering this question let us return first to the three expected outcomes of computer use for every student.*

a. Computer literacy. A computer facility as powerful as a maxicalculator is needed if all students, and many teachers and administrators, are to realize what computers can and cannot do and something of the impact of computers on the lives of us all. Calculators smaller than the maxicalculators are less powerful and less easy to use for a visible variety of purposes that each member of the school community can relate to. Only a few members of the community will need the added power of computers that are larger than the maxicalculators and generally more expensive.

The maxicalculators can illustrate all elements of computer services (and the dangers of unwise or malevolent actions supported by computers) that must be understood in the process of achieving computer literacy.

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* We not that all uses of the computer for the whole school requires that the system be flexible, easy to use and "ready to go." Otherwise students and teachers will be "turned off," and for a good reason!

But it must not be forgotten that the content and quality of the classroom teaching about computer literacy (and not just in mathematics classes!) influences the success of this outcome for the students as much as does the nature of the computer. The success of this outcome also depends upon software (like programs illustrating many uses of computers and an easy-to-learn language such as BASIC) that makes computer experience accessible to all students. Seeking the other two outcomes places similar requirements upon the hardware and software.

b. An elementary knowledge of BASIC. There is every reason to have the best version of BASIC available (and this is available on two of the maxicalculators). Any user can then make the most effective use of the calculator for his purposes without being hampered in his programming (or dependent on someone else's fancy programming to get around the limitations of a poor implementation of BASIC).*

The quality of the teaching and advising of students learning the elements of BASIC, whether aided by student-consultants or by teachers, and the quality of the off-line material, contribute as much to the success of the training in elementary BASIC as does the quality of the BASIC implementation on the computer. On-line materials (exercises, tutorials, definitions of commands, good diagnostics, etc.) have their place too, especially the good diagnostics. But it is unwise to assume that most of the elementary BASIC training of students of different ability and interests can be left to the computer alone! Each student's needs and idiosyncrasies must be matched by help from a perceptive person (student-consultant or teacher) as well as by the limited help that a computer lesson or diagnostics can give.

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* The use of APL should not be ruled out. APL is a very well-designed and powerful language, much easier to learn than is generally appreciated, and recently developed in hard-wired form in an inexpensive computer made by Micro Computer Machines.

c. Community. The computer by itself does not create community. It is people who achieve community, and even the older, less powerful and less portable minicomputers can assist skilled cadres of students and teachers in creating community. But the easier it is for each user to have "hands-on" or nearly "hands-on" experience on the computer, and the greater the computer's flexibility the more direct will be the computer's contribution to achieving community throughout the school. It appears that the maxicalculator supplies this "hands-on" use with the greatest flexibility and economy.

When a student has direct access to a maxicalculator as his helper in his own school-based tasks then he can be motivated to use it and understand its role in his life. A part of this motivation can be achieved by the student if he uses the smaller, programmable calculators. However, if he does no programming with them then he is just speeding up his arithmetic calculations or at most making use of canned functions and programs whose somewhat mysterious but trivial nature he may not fully understand. If he does programming on one of these smaller machines he will find it more difficult than using BASIC on the maxicalculators and much more restricted in programming power and in ease and flexibility of input-output. He thus will find it less convenient than the maxicalculator for doing many of his own personal little problems, which he needs to solve in his own way.

Small programmable calculators can have a valuable place in the school, but these smaller machines cannot take the place of the maxicalculators, nor of terminals using BASIC on a time-sharing system.

d. Other aspects of hardware and software. One question enters into the consideration of each of the three desired outcomes for the students, the question of what are the effective roles of the maxicalculators vs. time-sharing, interactive terminals in computers for the whole school. A partial answer to this question is needed here even though a full treatment must wait until more data covering computer applications in the schools have been collected and analyzed.

The fast batch capabilities of the maxicalculator will provide inexpensive computer service for hundreds of students (60 or more student jobs per hour) while leaving more than half of the school day for hands-on operation of the calculator. The interactive terminal is much more expensive per student job run. It can give immediate interaction for the user (a capability that is not always needed or desirable) but not the feel of handling one's own data and programs as visible, tangible card decks.* Time-sharing interaction does not enable the user to prepare these (mark sense) card decks at home or in the classroom. The hands-on operation of the maxicalculator (when it is not being used for fast batch) amounts to the use of a "super" time-sharing terminal, with many capabilities not found in the terminals commonly used for time-sharing.

The power of the versions of BASIC available on the maxicalculator and time-sharing terminals are and should be equivalent--only the best should be considered acceptable in either case. A good time-sharing system (but not all of them!) provide flexible, easy-to-use file management, and so does the maxicalculator. It has been customary to do large

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* The novices in computer use often like to use mark-sense cards rather than an interactive terminal, but this is only one factor of many to consider in comparing the interactive and noninteractive modes of computer use.

calculations in batch mode on large computers rather than through time-sharing. This distinction is now a fuzzy one because a time-sharing terminal can be given access to precompiled (therefore faster and more economical) programs and may also be used to control batch operations. Also, the distinction is not relevant here: all but a small fraction of the jobs in a school, in either instructional or administrative applications of the computer, can be run efficiently on the maxicalculator, because its design represents an effective balance among speed, memory size and ease of use.

The matter of memory size is linked to another aspect of computer use, that of security for each user's files (programs and data). The maxicalculator provides about 80,000 bytes of memory (about 80,000 alphanumeric characters, or 20,000 numbers or 2,000 lines of BASIC programs) on each of the user's tape cassettes.* The security for files is assured simply by removing the cassette and taking it away from the calculator. No "sign-on" or "file protect" codes are needed, as they are in the time-sharing system, codes that can always be broken and frequently are!

7. Concluding Remarks

We have discussed several aspects of student roles and computers for the whole school. We have described the activities of the students in using the computer rather than describing how these activities are developed in a school, preferring to consider this developmental aspect in a separate paper.

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* Disk memory of up to ten million bytes capacity can be added to the maxicalculator, and it can drive a plotter or connect to a larger computer, but we shall not discuss these and other exetnsions of its capability here.

The activities of students are discussed briefly in many reports and papers but is seldom the focus of the discussion. One recent paper (Reference 9) is, however, of special interest because it analyzes the experience with six rather different computer related learning projects in colleges and secondary schools.

As with many papers in the Series, our discussion here is introductory and exploratory, though it is based upon long experience in a few schools. We expect that the further experience of students, teachers and administrators in the schools and of staff and students at the University will help us in the future to modify and extend our discussion of student roles where this is needed.

References

1. Goddard, Wm. P., and Bruce Hicks, "Applications of Computers in the Whole School--Five Examples." ISEAC No. 1, Department of Secondary Education, University of Illinois. March 1975.

2. Kern, Paul D. (Principal, Adlai E. Stevenson High School), Private communication.

3. Kemeny, John D., and Thomas Kurtz, "BASIC Programming." John Wiley and Sons, (New York) 1971 (Second edition).

4. Coan, James S., "Basic BASIC." Hayden Book Co. (New York), 1970.

5. Goddard, Wm. P., Workshop on Computers and the Whole School. July, 1974 at the University of Illinois.

6. Goddard, Wm. P., "Computers and the Whole School." Workshop on computer mathematics for teacher educators, November, 1971, at the University of Illinois.

7. Critchfield, Margot D., and Thomas A. Dwyer, "Computers and the Romantic View of Education." The Journal, v. 2, no. 3. September 1974, pp. 4-9.

8. Dirks, Douglas, Ted Singletary, and Bruce Hicks, "A Study of Computer Simulations for Environmental Science Education." ISEAC No. 2, Department of Secondary Education, University of Illinois. February, 1975.

9. Bell, Frederick H., Why is Computer-Related Learning so Successful?, Educational Technology v. 24, no. 12, pp. 15-18. December 1974.

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